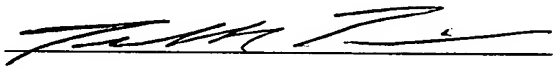
REMARKS

In view of the forgoing preliminary amendment to the claims, it is submitted that all of the claims remaining in the application are now in condition for allowance and such action is respectfully requested. Should any questions arise in connection with this application or should the Examiner believe that a telephone conference with the undersigned would be helpful in resolving any remaining issues pertaining to this application, the undersigned respectfully requests that she be contacted at the number indicated below.

For the reasons outlined above, withdrawal of the rejection of record and an allowance of this application are respectfully requested.

Respectfully submitted,

By: 

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(Substitute Specification With Markings)

ASYNCHRONOUS MESSAGING IN STORAGE AREA NETWORK

~~Field of the Invention~~

BACKGROUND OF THE INVENTION

Technical Field

This invention relates to systems for asynchronous messaging-and-queuing, and more particularly for the control of storage of messages.

~~Background of the Invention~~

Description Of The Prior Art

Asynchronous messaging-and-queuing systems are well known in the art. One such is the ~~IBM MQSeries~~IBM® MQSeries® messaging-and-queuing product. (IBM and MQSeries are registered trade marks of IBM Corporation.) An MQSeries system is used in the following description, for convenience, but it will be clear to one skilled in the art that the background to the present invention comprises many other messaging-and-queuing systems.

In an MQSeries message queuing system, a system program known as a "queue manager" provides message queuing services to a group of applications which use the queue manager to send and receive messages over a network. A number of queue managers may be provided in the network, each servicing one or more applications local to that queue manager. A message sent from one application to another is stored in a message queue maintained by the queue manager local to the receiving application ~~until~~ until the receiving application is ready to retrieve it. Applications can retrieve messages from queues maintained by their local queue manager, and can, via the intermediary of their local queue manager, put messages on queues maintained by queue

managers throughout the network. An application communicates with its local queue manager via an interface known as the MQI (Message Queue Interface). This defines a set of requests, or "calls", that an application uses to invoke the services of the queue manager. In accordance with the MQI, an application first requests the resources which will be required for performance of a service, and, having received those resources from the queue manager, the application then requests performance of the service specifying the resources to be used. In particular, to invoke any queue manager service, an application first requires a connection to the queue manager. Thus the application first issues a call requesting a connection with the queue manager, and, in response to this call, the queue manager returns a connection handle identifying the connection to be used by the application. The application will then pass this connection handle as an input parameter when making other calls for the duration of the connection. The application also requires an object handle for each object, such as a queue, to be used in performance of the required service. Thus, the application will submit one or more calls requesting object handles for each object to be used, and appropriate object handles will be dispensed by the queue manager. All object handles supplied by the queue manager are associated with a particular connection handle, a given object handle being supplied for use by a particular connection, and hence for use together with the associated connection handle. After receiving the resources to be used, the application can issue a service request call requesting performance of a service. This call will include the connection handle and the object handle for each object to be used. In the case of retrieving a message from a queue for example, the application issues a "get message" call including its connection handle and the appropriate queue handle dispensed to the application to identify the connection and queue to the queue manager.

———With asynchronous messaging systems available today, when a message arrives at a server it is only available to that ~~server, and should that server fail,~~server. In the event of failure of that server, the message is "trapped" in the server until the server can be~~restarted.~~

~~In~~restarted. For example, in high capacity or high performance application architectures the storage of messages in ~~single servers is also a limitation, as a determination has to be made, typically before a message is sent,~~individual servers is a limitation. The individual server has to determine that the intended destination server is able to handle the message and any subsequent processing required in a timely ~~manner.~~ manner. Typically, this determination has to be made by the server before a message is sent. Accordingly, there are limitations associated with prior art asynchronous messaging systems.

~~There is clearly~~Therefore, there is a need for a more robust and flexible method ~~and~~ and system for storage of asynchronous messages in such systems. Preferably, such a method and system will centralize storage and processing of messages to eliminate shortcomings associated with failure of servers and messages stored therein.

SUMMARY OF THE INVENTION

~~The present~~This invention ~~accordingly provides, in a first aspect, a computer system comprising:~~comprises an asynchronous messaging-and-queuing system in communication with a storage area network to mitigate loss of messages among servers in communication with the storage area network.

~~system;~~In one aspect of the invention, a computer system is provided with an asynchronous message and queue system and a storage area network ~~having~~controller in communication with the asynchronous message and queue system to control a queue held in a storage area ~~network controller; and wherein said~~network. The storage area network controller ~~comprises~~is provided with control means to control a message queue on behalf of~~one or more queue managers.~~

~~Preferably, said one or more queue managers comprise two or more queue managers, and at least two of said two or more queue managers are heterogeneous.~~

~~Preferably, a message in said message queue is persistent, and wherein said~~a queue manager. In addition, the storage area network controller controls a transactional or persistent message.

In another aspect of the invention, a method is provided for communicating in a computer system. A queue in a storage area network of the computer system is managed to support an asynchronous messaging and queuing system. A message request is received at a queue manager of the storage area network. The message request is passed to a storage area network controller of the storage area network, wherein the controller controls has means to control a message that may be in the form of a transactional message or a persistent message.

In yet another aspect of the invention, an article is provided in a computer-readable signal-bearing medium. Means in the medium are provided for managing a queue in a storage area network of an asynchronous messaging and queuing system. Means in the medium are provided for receiving a message request at a queue ~~comprises~~manager of a storage area network, and for passing the message request to a storage area network controller of the storage area network. The controller includes control means for controlling ~~persistence of said~~a transactional or persistent message.

~~Preferably, said message is a transactional message, and wherein said storage area network controller comprises transactional control means.~~

~~Preferably, said transactional control means comprises a syncpoint coordinator.~~

~~Preferably, said storage area network controller comprises data integrity control means.~~

~~Preferably, said data integrity control means comprises a lock manager.~~

~~In a second aspect, the present invention provides a method for controlling a computer system having~~In a further aspect of the invention, an asynchronous ~~messaging and queuing system and~~message-and-queue system is provided with a storage area network having a~~storage area network controller; comprising the steps of: receiving a message request at a queue manager; and passing said message request to said storage area network controller; wherein said~~controller to manage a queue in the storage area network. The storage area network controller ~~comprises control means to control message queues on behalf of one or more queue managers.~~includes means to control a transactional or persistent message.

~~Preferred method features of the method of the second aspect correspond to the means provided by preferred features of the first aspect.~~

~~In a third aspect, the present invention provides a computer program to cause a computer system perform computer program steps corresponding to the steps of the method of the second aspect.~~

~~Using a Storage Area Network (SAN) to hold the message data not only centralizes data storage, it also provides a more robust overall solution, as there is no single point of failure.~~

In an even further aspect of the invention, a method is provided for controlling messaging. A queue in a storage area network of an asynchronous messaging and queuing system is managed, and a transactional or persistent message is controlled.

In yet a further aspect of the invention, an article is provided in a computer-readable signal-bearing medium. Means in the medium are provided for managing a queue in a storage area network of an asynchronous messaging and queuing system. In addition, means in the medium are provided for controlling a transactional or persistent message in the queue.

Other features and advantages of this invention will become apparent from the following detailed description of the presently preferred embodiment of the invention, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a block diagram representing the component parts of a system according to a preferred embodiment of the present invention, and is suggested for printing on the first page of the issued patent.

Figure 2 is illustrative of the load-balancing capability of a system according to a preferred embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Overview

~~One definition of SAN is a high speed~~A storage area network (SAN) is used to centralize and control message data and to eliminate a single point of failure in the message system. The SAN is a high speed network, comparable to a LAN, that allows the establishment of direct connections between storage devices and ~~processors (servers).~~processors. The SAN can be viewed as an extension to the storage bus concept that enables storage devices and servers to be interconnected using similar elements as in

~~Local Area Networks (LANs) and Wide Area Networks (WANs): routers, hubs, switches and gateways.~~local area networks and wide area networks. A SAN can be shared between servers and/or dedicated to one server. It can be local or can be extended over geographical ~~distances.~~
distances. With implementation

~~It would be possible, in an embodiment of the present invention, to merely agree a set of protocols for data integrity, transactionality, and other qualities of service between the various cooperating components. In such a case, data integrity, syncpoint coordination, etc. would be conducted and controlled by a middleware layer, which would supply the appropriate set of primitives to the SAN controller and to the applications and queue managers.~~

~~By contrast, not only does the presently most preferred embodiment of this invention remove the~~of the SAN, storage of messages are removed from individual servers and instead ~~store them~~stored at the network~~level, in a SAN, but also provides the support infrastructure in the SAN to supply all required data integrity functionality, allowing multiple queue managers to access the queue (for read and write operations)simultaneously, with complete confidence.~~

~~Conventionally, a queue is owned by a specific queue manager, which is responsible for ensuring that multi-threaded access to that queue is maintained in an orderly and correct manner. By moving the queue to the SAN,~~level. The queue is also moved to the SAN and ownership of the queue is removed from the queue manager and is vested with ~~the~~a SAN controller. Queue managers can~~apparently~~ access and manipulate messages on the queue as they would a locally owned queue, but the~~real,~~ underlying management of the manipulation is maintained within the SAN~~controller.~~

~~In order for this to work, the SAN Controller may provide the primitives required to control the~~controller which provides primitives to control locking and transactional integrity for the messages on the queue(s) it owns.

~~There are several benefits in the preferred embodiments of the present invention. The first is that messages (data) are removed from the more fragile application server environment into the more robust SAN, where, instead of only being accessible by one server, potentially any server which can connect to the SAN can access the messages.~~

~~The same benefits cannot be gained simply by mounting the file system holding the queue data, where multiple servers could potentially mount and use the files. If this were to be allowed, conflict situations where, for example, messages locked by one queue manager were deleted by another would rapidly arise, and would make any such system~~

completely unworkable.

By adding locking and two phase commit primitives to the SAN Controller, a preferred embodiment of the present invention allows multiple servers to connect to the SAN and thus simultaneously access the messages - on queues (for reads, writes, deletes, locks and transactional operations), with the same level of data integrity that is offered by a single queue manager controlling multi-threaded access to a single queue.

A secondary benefit is that it is possible to filter all messages inbound to a particular application to one queue maintained in the SAN. From there they can be distributed to any number of connected servers for subsequent processing by the application with complete transparency to the application.

The final main benefit is that since all message data is centrally located, providing for backup and disaster recovery is greatly simplified, as all pertinent data is located in one place, and base SAN services can be utilized to ensure that a secure copy is made.

Messages can have the property of being "persistent" - that is they must be logged and journaled by the queue manager before any subsequent processing can occur - or they can be "non-persistent", in which case the message is discarded in the event of a queue manager failure. Preferred embodiments of the present invention are particularly suitable for the control of queues where persistent messages may be placed.

The requirement for securing data is the same in a queue controlled by the SAN as it is in a queue locally controlled by a queue manager - that is, authority is required to create and delete a queue, as well as to write and read messages to and from the queue. There are already mechanisms in place (queue clustering) for publishing queue definitions to multiple queue managers, and for providing access control (the local queue manager would determine if access was valid).

The SAN Controller would preferably police the connection of queue managers to the SAN, and thereafter assume that a request for queue manipulation sent by a connected queue manager had been validated.

Since message data would be flowing over networks, the option to encrypt the data between the SAN and the queue manager would also be a preferred feature.

It will be clear to one skilled in the art that the presently preferred embodiment involves the transfer of attributes and activities normally associated with a middleware layer distributed about a networked system into a SAN controller in order to achieve improved robustness, scalability, centralisation of control and ease of maintenance, among other advantages. The attributes and activities associated with middleware are

~~often referred to as "Quality of Service" definitions. It would be possible, as described above, simply to transfer the queue data structures from the local storage of the queue managers into the SAN, and leave the queue managers to negotiate protocols among themselves to manage locking and syncpointing, possibly by means of the conventional middleware provisions. However, as described above, the presently most preferred embodiment of the present invention offers advantages that go beyond those offered by such a solution.~~

~~As will be clear to one skilled in the art, there will be many other "Quality of Service" definitions that can be incorporated into a SAN controller in the same way as can transactionality, syncpoint coordination, recoverability and so on. One example of such a Quality of Service definition is "Compensability" for subtransactions of a long-running transaction.~~

~~BRIEF DESCRIPTION OF THE DRAWINGS~~

~~A preferred embodiment of the present invention will now be described by way of example only, with reference to the accompanying drawings, in which:~~

~~Figure 1 is a block diagram representing the component parts of a system according to a preferred embodiment of the present invention; and~~

~~Figure 2 is illustrative of the load-balancing capability of a system according to a preferred embodiment of the present invention.~~

~~DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT~~

Technical Details

Turning now to Figure 1, there are three main components of presently preferred embodiments of this invention which interact. The first is the SAN (102), controlled by the SAN controller ~~(104); the~~(104). The second is the queue manager (114), which is writing the message to a queue (108) held in the ~~SAN and the~~SAN. The third is a queue manager (122), looking to read that message from the SAN held queue (108). Each queue manager (114, 122) is acting on behalf of an application (112, 120) that is making requests that must be satisfied by the queue manager (114, 122). The queue managers (114, 122) and the requesting applications (112, 120) may be located

anywhere in a network. That is, systems or system components (110, 118) can be regions or partitions within a system, separate physical computer systems, distributed systems in a network, or any other combination of systems or system components.

———In particular, to invoke any queue manager service, an application (112, 120) first requires a connection to the queue manager (114, 122). Thus the application (112, 120) first issues a call requesting a connection with the queue manager (114, 122), and, in response to this call, the queue manager returns a connection handle identifying the connection to be used by the application. The application (112, 120) will then pass this connection handle as an input parameter when making other calls for the duration of the connection. The application (112, 120) also requires an object handle for each object, such as a queue (108), to be used in performance of the required service. Thus, the application (112, 120) will submit one or more calls requesting object handles for each object to be used, and appropriate object handles will be dispensed by the queue manager (114, ~~122).~~ 122). All object handles supplied by the queue manager (114, 122) are associated with a particular connection handle, a given object handle being supplied for use by a particular connection, and hence for use together with the associated connection handle. After receiving the resources to be used, the application (112, 120) can issue a service request call requesting performance of a service. This call will include the connection handle and the object handle for each object to be used. In the case of retrieving a message from a queue (108), for example, the application issues a "get message" call including its connection handle and the appropriate queue handle dispensed to the application to identify the connection and queue (108) to the queue manager (114, 122).

———Preferably, the SAN controller (104) of the preferred embodiment of the present invention is provided with a syncpoint coordinator (124), a persistence manager (126) and a lock manager (128). This enables centralization of functions that would

otherwise be devolved out to the queue managers, leading to potential problems that may arise in conventional messaging-and-queuing systems.

The preferred embodiment of the present invention is a highly suitable architecture for high throughput systems, with no chance of messages becoming "trapped" in a failed server, and the application throughput can also be "scaled up" by simply connecting more servers to the SAN. Conversely, if demand for the application falls, servers can be disconnected and the maximum possible throughput reduced, on a dynamic basis. As shown in Figure 2, if demand for processing messages in ~~queue~~ queue (208) rises beyond the capacity of one or more application servers (210), one or more expansion servers (212) can be connected to the SAN, and thus added to the available processing resource available.

Below are described the interactions that may be provided in a presently preferred embodiment of the invention.

Interaction 1 - Connection

~~100 Queue~~100 Queue Manager sends connection request to SAN Controller

~~105 SAN~~105 SAN Controller accepts connection request

~~110 SAN~~110 SAN Controller verifies identity of Queue Manager

~~115 If~~115 If identity confirmed, SAN Controller confirms connection request, else refuses connection

Interaction 2 - Defining a Queue

~~200 Administrator~~200 Administrator sends a request to define a queue on the SAN

~~205 SAN~~205 SAN Controller validates and if appropriate, accepts request

~~210 SAN~~210 SAN Controller allocates space for the queue on managed storage

~~215 SAN~~215 SAN Controller builds necessary control structures

~~220 SAN~~220 SAN Controller confirms completion of queue creation

Interaction 3 - Opening a handle to a queue

~~300 Queue~~300 Queue Manager sends request to open a handle to a queue

~~305 SAN~~305 SAN Controller confirms existence of queue and authority to open handle

310 If queue does not exist or incorrect authority, fail the request

~~315 SAN~~315 SAN Controller opens and returns handle to requesting queue manager

320 SAN Controller updates a usage counter for the queue

Interaction 4 - Placing a message on the queue

400 Queue Manager sends a message to place on a queue

405 SAN Controller verifies authority to place message on queue.

410 SAN Controller writes message data into allocated, managed storage

415 SAN Controller checks if write is part of syncpoint

420 If part of syncpoint, SAN Controller places lock on message, confirms to application

425 If not in syncpoint, SAN Controller confirms message written to queue

Interaction 5 - Confirming syncpoint (simplified) (read and ~~write~~ write operations)

500 Queue Manager sends syncpoint confirmation to SAN Controller

505 SAN Controller confirms queue operation (read or write)

510 SAN Controller clears lock on message, and removes message from queue if read operation

Interaction 6 - Backing out syncpoint (simplified) (read and write operations)

600 Queue Manager sends syncpoint back out to SAN Controller

605 SAN Controller confirms queue operation backed out (read or write)

610 SAN Controller clears lock on message, and removes message from queue if write operation.

Note that any syncpoint operations would typically be of the two phase commit type, but this level of detail is not needed in the present description. Between the SAN Controller and an attached queue manager, a full two phase commit may not be necessary.

Interaction 7 - Reading a message from a queue

700 ___Queue Manager sends a read request message to SAN Controller

705 ___SAN Controller checks if request is for specific message. If so, Interaction 8 - Reading a specific message

710 ___SAN Controller determines next available message to be read

715 ___If not a browse, SAN Controller locks message, and checks if read is under syncpoint

720 ___SAN Controller sends message and marks syncpoint if needed

725 ___If read is not a browse and out of syncpoint, message is removed from managed storage

Interaction 8 - Reading a specific message from a queue

800 ___SAN Controller checks if message exists and is not locked by other queue manager

805 ___If message is locked or does not exist, read request is rejected

810 ___If not a browse, SAN Controller locks message, and checks if read is under syncpoint

815 ___SAN Controller sends message and marks syncpoint if needed

820 ___If read is not a browse and out of syncpoint, message is removed from managed storage

Interaction 9 - Closing a handle to a queue

900 ___Queue Manager sends request to close queue handle

905 __SAN Controller verifies request and decrements usage counter

910 __SAN Controller checks the usage counter for the queue

912 __SAN Controller checks for any uncommitted syncpoints, and if found, rejects close handle request

915 __If usage count is 0, SAN Controller deletes queue handle

920 __If usage count is not 0, SAN Controller rejects close request

Interaction 10 - Deleting a queue

1000 _Administrator sends request to delete queue

1005 _If request is a "force delete" then delete queue and free allocated managed storage

1015 _SAN Controller verifies that no messages are locked under syncpoint

1020 _SAN Controller verifies that no other queue managers have open handles
1025 If above tests are true, then delete queue and free allocated managed storage

1030 _If any tests above are false, then reject close request.

Interaction 11 - Listing owned queues

1100 _Queue manager or system management API sends request to list owned queues

1105 _SAN Controller sends details

Interaction 12 - Amending queue definition

1200 _Queue manager or system management API sends request to amend queue definition

1205 _SAN Controller verifies request possible and executes changes.

Interaction 13 - Queue Manager Health Check

1300 _SAN Controller sends health check to each connected queue manager

1305 _If no response from health check, SAN Controller disconnects failed queue manager

Interaction 14 - Disconnect failed Queue Manager

1400 _SAN Controller terminates each handle owned by the failed queue manager

1405 _SAN Controller checks for all uncommitted syncpoints, and backs them out

1410 _SAN Controller closes all open handles to queue

1415 _SAN Controller closes connection handle to failed queue manager

1420 _SAN Controller reports failure event

~~ABSTRACT~~

Messages can have the property of being persistent or they can be non-persistent. A persistent message must be logged and journaled by the queue manager before any subsequent processing can occur, and a non-persistent message is discarded in the event of a queue manager failure. The centralization of messaging supported by the use of the SAN and SAN controller is particularly suitable for the control of queues where persistent messages may be placed.

Advantages Over The Prior Art

By moving the storage of messages to a SAN, support infrastructure in the SAN may be used to supply all required data integrity and functionality to allow multiple queue managers to access the queue simultaneously for read and write operations. Other advantages include removal of messages, *i.e.* data, from the application server where instead of being accessible by one server, the messages are potentially accessible by any server which can connect to the SAN. An addition of locking and two phase commit primitives to the SAN controller allows multiple servers to connect to the SAN and to simultaneously access the messages on the queues for reads, writes, deletes, locks, and transactional operations, with the same level of data integrity that is offered by a single queue manager controlling multi-threaded access to a single queue. Another benefit is that it is possible to filter all messages inbound to a particular application to one queue maintained in the SAN. From there they can be distributed to any number of connected servers for subsequent processing by the application with complete transparency to the application. Finally, since all message data is centrally located, providing for backup and disaster recovery is simplified as all persistent data is located in one place, and base SAN services can be utilized to ensure that a secure copy is made.

Alternative Embodiments

It will be appreciated that, although specific embodiments of the invention have been described herein for purposes of illustration, various modifications may be made without departing from the spirit and scope of the invention. In particular, a set of protocols may be provided for data integrity, transactionality, and other qualities of service between the various components. In such a case, data integrity, syncpoint coordination, *etc.* would be conducted and controlled by a middleware layer, which would supply the appropriate set of primitives to the SAN controller and to the applications and queue managers. Accordingly, the scope of protection of this invention is limited only by the following claims and their equivalents.

Abstract of the Disclosure

ASYNCHRONOUS MESSAGING IN STORAGE AREA NETWORK

A computer system includes an asynchronous ~~messaging-and-queuing~~ messaging-and-queuing system; and a storage area network having a storage area network ~~controller; and the~~controller in communication with the asynchronous messaging-and-queuing system. The storage area network controller includes control means to control a message queue on behalf of one or more queue managers, which may be heterogeneous.

The storage area network controller may also include means for controlling persistence of messages, transactional control means, such as a syncpoint coordinator, and data integrity control means, such as a lock manager.